IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant	Ravi Narasimhan	Art Unit:	2617
Serial No.:	10/656,001	Examiner:	Huy Q. Phan
Filed:	September 5, 2003	Conf. No.:	7519
Title:	SPATIAL MULTIPLEXING WITH ANTENNA AND CONSTELLATION SELECTION FOR CORRELATED MIMO FADING CHANNELS		

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BRIEF ON APPEAL

Applicant herewith files this brief on appeal under 37 CFR § 41.37, thereby perfecting the notice of appeal which was originally filed on January 16, 2007.

The section required by 37 CFR § 41.37 follows.

(1) Real Party in Interest

Marvell Semiconductor, Inc., the assignee of this patent application, is the real party in interest.

(2) Related Appeals and Interferences

There are no related appeals or interferences.

(3) Status of Claims

Claims 2, 4-11, 13, 15-22, 24, 26-33, 35, 37-44, 46, 48-55 and 57-59 are pending and claims 2, 4-8, 10, 13, 15-19, 21, 24, 26-30, 32, 35, 37-41, 43, 46, 48-52, 54 and 57 are rejected. Claims 4, 7, 9, 11, 15, 18, 20, 22, 26, 29, 31, 33, 37, 40, 42, 44, 48, 51, 53 and 55 are the independent claims. Claims 9, 11, 20, 22, 31, 33, 42, 44, 53, 55, 58 and 59 are the allowed claims. The rejection of claims 2, 4-8, 10, 13, 15-19, 21, 24, 26-30, 32, 35, 37-41, 43, 46, 48-52, 54 and 57 is appealed.

(4) Status of Amendments

The claims have not been amended subsequent to final rejection. There are no unentered amendments.

(5) Summary of Claimed Subject Matter

<u>Claim 4</u>

Claim Language	Support in Specification and/or FIGS.
A method comprising:	*See, e.g.,* ¶ FIG. 2, No. 200.
selecting a subset of active antennas from a plurality of available antennas in a multi-element antenna system based on higher-order statistics of a propagation medium; and	*See, e.g.,* ¶ [0017], ll. 1-18; ¶ [0036], ll. 1-6; ¶ [0055], ll. 1-15; and FIG. 2, No. 210.
selecting a constellation for transmission on the active antennas, where said selecting	*See, e.g.,* ¶ [0017], ll. 8-17; ¶ [0037], ll. 1-8; ¶ [0053], ll. 6-10; ¶ [0054], ll. 4-8; and

the constellation for transmission on the active antennas comprises selecting different constellations for two or more of the active antennas.	FIG. 2, No. 215.

Claim 7

Claim Language	Support in Specification and/or FIGS.
A method comprising:	*See, e.g.,* ¶ FIG. 2, No. 200.
selecting a subset of active antennas from a plurality of available antennas in a multi-element antenna system based on higher-order statistics of a propagation medium, where said selecting comprises selecting an optimum number of antennas to maximize a minimum signal-to-noise ratio (SNR) margin.	*See, e.g.,* ¶ [0017], ll. 1-18; ¶ [0021], ll. 1-3; ¶ [0030], ll. 1-2; ¶ [0036], ll. 1-6; ¶ [0055], ll. 1-15; and FIG. 2, No. 210.

Claim 15

Claim Language	Support in Specification and/or FIGS.
An apparatus, comprising:	*See, e.g.,* FIG. 1, No. 100 and ¶ [0017], 1-18.
a processor operative to select a subset of active antennas from a plurality of available antennas based on higher-order statistics of a propagation medium, wherein the processor is operative to select a constellation for transmission on the active antennas and to select different constellations for two or more of the active antennas.	*See, e.g.,* ¶ [0017], ll. 1-18; ¶ [0036], ll. 1-6; ¶ [0037], ll. 1-8; ¶ [0053], ll. 6-10; ¶ [0054], ll. 4-8; ¶ [0055], ll. 1-15; FIG. 1, No. 150; and FIG. 2, Nos. 210 and 215.

Claim 18

Claim Language	Support in Specification and/or FIGS.
An apparatus comprising:	*See, e.g.,* See, e.g., FIG. 1, No. 100 and ¶ [0017], 1-18.
a processor operative to select a subset of active antennas from a plurality of available antennas based on higher-order statistics of a propagation medium where the processor is operative to select an	*See, e.g.,* ¶ [0017], ll. 1-18; ¶ [0021], ll. 1-3; ¶ [0030], ll. 1-2; ¶ [0036], ll. 1-6; ¶ [0055], ll. 1-15; FIG. 1, No. 150 and FIG. 2, No. 210.

optimum number of antennas to maximize a minimum signal-to-noise ratio (SNR) margin.	

Claim 26

Claim Language	Support in Specification and/or FIGS.
An apparatus comprising:	*See, e.g.,* See, e.g., FIG. 1, No. 100 and ¶ [0017], 1-18.
a processor including means for selecting a subset of active antennas from a plurality of available antennas based on higher-order statistics of a propagation medium and means for selecting a constellation for transmission on the active antennas including means for selecting different constellations for two or more of the active antennas.	*See, e.g.,* ¶ [0017], ll. 1-18; ¶ [0036], ll. 1-6; ¶ [0037], ll. 1-8; ¶ [0038], ll. 1-14; ¶ [0053], ll. 6-10; ¶ [0054], ll. 4-8; ¶ [0055], ll. 1-15; FIG. 1, No. 150; and FIG. 2, Nos. 210 and 215.

Identification of Means Plus Function	Support in Specification and/or FIGS.
means for selecting a subset of active antennas from a plurality of available antennas based on higher-order statistics of a propagation medium	*See, e.g.,* ¶ [0017], ll. 1-14; ¶ [0021], ll. 1-7; ¶ [0038], ll. 1-14;FIG. 1, No. 150; and FIG. 2, No. 210.

means for selecting a constellation for transmission on the active antennas including means for selecting different constellations for two or more of the active antennas	*See, e.g.*, ¶ [0017], ll. 1-14; ¶ [0037], ll. 1-10; ¶ [0038], ll. 1-14; ¶ [0053], ll. 3-10; ¶ [0054], ll. 4-6; FIG. 1, No. 150; and FIG. 2, No. 215.

Claim 29

Claim Language	Support in Specification and/or FIGS.
A system comprising:	*See, e.g.*, See, e.g., FIG. 1, No. 100 and ¶ [0017], 1-18.
a processor including means for selecting a subset of active antennas from a plurality of available antennas based on higher-order statistics of a propagation medium, where said selecting comprises selecting an optimum number of antennas to maximize a minimum signal-to-noise ratio (SNR) margin.	*See, e.g.*, ¶ [0017], ll. 1-18; ¶ [0021], ll. 1-3; ¶ [0030], ll. 1-2; ¶ [0036], ll. 1-6; ¶ [0055], ll. 1-15; FIG. 1, No. 150 and FIG. 2, No. 210.

Identification of Means Plus Function	Support in Specification and/or FIGS.
means for selecting a subset of active antennas from a plurality of available antennas based on higher-order statistics of a propagation medium	*See, e.g.,* ¶ [0017], ll. 1-14; ¶ [0021], ll. 1-7; ¶ [0038], ll. 1-14;FIG. 1, No. 150; and FIG. 2, No. 210.

Claim 37

Claim Language	Support in Specification and/or FIGS.
A system comprising:	*See, e.g.,* See, e.g., FIG. 1, No. 100 and ¶ [0017], 1-18.
a propagation medium;	*See, e.g.,* ¶ [0013], ll. 1-5; ¶ [0017], ll. 11-14; ¶ [0055], ll. 1-15; FIG. 1, No. 140.
a first transceiver including a plurality of available antennas;	*See, e.g.,* ¶ [0010], ll. 1-7; ¶ [0011], ll. 1-7; ¶ [0017], ll. 1-7; FIG. 1, Nos. 105 and 110.
a second transceiver including a plurality of available antennas a processor operative to determine higher-order statistics of the propagation medium from signals received from the plurality of available antennas at the first transceiver; and	*See, e.g.,* ¶ [0010], ll. 1-13; ¶ [0011], ll. 1-7; ¶ [0017], ll. 1-7; ¶ [0056], ll. 1-15; FIG. 1, Nos. 115, 120, 125 and 130.
an antenna selection module operative to select a subset of active antennas from the	*See, e.g.,* ¶ [0017], ll. 1-18; ¶ [0036], ll. 1-6; ¶ [0037], ll. 1-8; ¶ [0053], ll. 6-10; ¶

plurality of available antennas based on higher-order statistics of the propagation medium, where the processor is operative to select a constellation for transmission on the active antennas and select different constellations for two or more of the active antennas.	[0054], ll. 4-8; ¶ [0055], ll. 1-15; FIG. 1, No. 150; and FIG. 2, Nos. 210 and 215.

Claim 40

Claim Language	Support in Specification and/or FIGS.
A system comprising:	*See, e.g.,* See, e.g., FIG. 1, No. 100 and ¶ [0017], 1-18.
a propagation medium;	*See, e.g.,* ¶ [0013], ll. 1-5; ¶ [0017], ll. 11-14; ¶ [0055], ll. 1-15; FIG. 1, No. 140.
a first transceiver including a plurality of available antennas;	*See, e.g.,* ¶ [0010], ll. 1-7; ¶ [0011], ll. 1-7; ¶ [0017], ll. 1-7; FIG. 1, Nos. 105 and 110.
a second transceiver including a plurality of available antennas a processor operative to determine higher-order statistics of the propagation medium from signals received from the plurality of available antennas at the first transceiver;	*See, e.g.,* ¶ [0010], ll. 1-13; ¶ [0011], ll. 1-7; ¶ [0017], ll. 1-7; ¶ [0056], ll. 1-15; FIG. 1, Nos. 115, 120, 125 and 130.

and	
an antenna selection module operative to select a subset of active antennas from the plurality of available antennas based on higher-order statistics of the propagation medium, where the processor is operative to select an optimum number of antennas to maximize a minimum signal-to-noise ratio (SNR) margin.	*See, e.g.*, ¶ [0017], ll. 1-18; ¶ [0021], ll. 1-3; ¶ [0030], ll. 1-2; ¶ [0036], ll. 1-6; ¶ [0055], ll. 1-15; FIG. 1, No. 150 and FIG. 2, No. 210.

Claim 48

Claim Language	Support in Specification and/or FIGS.
A computer program comprising the steps of:	*See, e.g.*, ¶ [0056], ll. 1-7; FIG. 2, No. 200.
selecting a subset of active antennas from a plurality of available antennas in an multi-element antenna system based on higher-order statistics of a propagation medium; and	*See, e.g.*, ¶ [0017], ll. 1-18; ¶ [0036], ll. 1-6; ¶ [0055], ll. 1-15; and FIG. 2, No. 210.
selecting a constellation for transmission on the active antennas including selecting different constellations for two or more of the active antennas.	*See, e.g.*, ¶ [0017], ll. 8-17; ¶ [0037], ll. 1-8; ¶ [0053], ll. 6-10; ¶ [0054], ll. 4-8; and FIG. 2, No. 215.

Claim 51

Claim Language	Support in Specification and/or FIGS.
A computer program comprising the steps of:	*See, e.g.,* ¶ [0056], ll. 1-7; FIG. 2, No. 200.
selecting a subset of active antennas from a plurality of available antennas in an multi-element antenna system based on higher-order statistics of a propagation medium where said selecting comprises selecting an optimum number of antennas to maximize a minimum signal-to-noise ratio (SNR) margin.	*See, e.g.,* ¶ [0017], ll. 1-18; ¶ [0021], ll. 1-3; ¶ [0030], ll. 1-2; ¶ [0036], ll. 1-6; ¶ [0055], ll. 1-15; and FIG. 2, No. 210.

(6) Grounds of Rejection to be Reviewed on Appeal

Claims 2, 4-8, 10, 13, 15-19, 21, 24, 26-30, 32, 35, 37-41, 43, 46, 48-52, 54 and 57 stand rejected under 35 U.S.C. § 103(a) as allegedly being unpatentable over Malaender et al. ("Malaender", U.S. Patent Application Publication No. 2003/0223391) in view of Kadous ("Kadous", U.S. Patent No. 6,801,580.)

(7) Argument

Claim 4 and its dependent claims

Claims 2, 4, 5, 6, 8 and 10 were rejected as allegedly being unpatentable over Malaender in view of Kadous.

Claim 4 is directed to a method that includes selecting a subset of active antennas from a plurality of available antennas in a multi-element antenna system, and selecting a constellation for transmission on the active antennas including selecting different constellations for two or more of the active antennas. Applicant's specification provides an example. "As a result of antenna and constellation selection, Antennas 1, 2, and 3 transmit a 16-QAM constellation for the linear and V-BLAST system. For the SCR system, Antennas 1 through 5 are active with transmit constellations 8-PSK, 8-PSK, QPSK, QPSK, and QPSK, respectively." (Applicant's Specification at ¶ 52.)

Malaender is directed to a method and system for employing antenna arrays. In the method, Malaender discloses techniques for adjusting a number of antennas to employ, the on/off patterns for the antennas, and the eigenmode values. (*See* Malaender at Abstract.) However, Malaender does not teach or suggest selecting a constellation for transmission on the active antennas <u>including selecting different constellations for two or more of the active antennas.</u> In fact, the Examiner concedes that "Malaender fails to expressly teach selecting a constellation for transmission on the active antennas where said selecting the constellation for transmission on the active antennas comprises selecting different constellations [for] two or more of the active antennas." (*See* Office Action Dated October 17, 2006 at pg. 4.) The addition of Kadous fails to alleviate the deficiencies of Malaender.

The Examiner alleges that Kadous discloses the claimed feature at col. 17, ll. 40-59; figs. 5; cols. 16-18; col. 14, ll. 6-10; fig. 4; and cols. 14-16. (*See* Office Action Dated October 17, 2006 at pgs. 2-5.) However, the cited portions of Kadous fail to support the allegation.

Kadous is directed to "techniques to process a number of received symbol streams, using successive interference cancellation (SIC) processing, to recover a number of transmitted symbol streams." (*See* Kadous at Col. 3, ll. 43-48. Emphasis added.) Thus, Kadous is directed to merely processing the received symbol streams. Kadous does not teach or suggest varying the number of antennas or the constellations selected for the antennas in a transmission system. In contrast to claim 4, Kadous teaches that the received symbol streams are transmitted from a set number of antennas, all having the same predetermined constellation. (*See,* Kadous at Col. 14, ll. 6-10.) For example, the cited portions of Kadous disclose that "performance [of various SIC processing schemes] is provided for a (2,4) MIMO system with two transmit antennas and four receive antennas, and which uses **16-QAM** with rate 1/2 Turbo coding." (*See* Kadous at Col. 14, ll. 6-10; FIG. 4. Emphasis added.) Therefore, all of the antennas in Kadous use the same constellation, **16-QAM**. In fact, Kadous is silent as to selecting different constellations for two or more of the active antennas (i.e., at least two different constellations for two antennas) and nothing in Kadous can be reasonably construed to teach or suggest otherwise.

Therefore, even if Malaender and Kadous could somehow be combined, which is not conceded, the combination would still fail to disclose each and every feature of claim 4. Accordingly, Applicant respectfully asserts that claim 4 as presented is allowable over the suggested combination of Malaender and Kadous for at least the above reasons.

Claims 2, 5, 6, 8 and 10 depend from claim 4 and are allowable over the proposed combination of Malaender and Kadous for at least the same reasons as claim 4 above.

Claim 7

Claim 7 was rejected as allegedly being unpatentable over Malaender in view of Kadous.

Claim 7 is directed to a method that includes selecting a subset of active antennas from a plurality of available antennas in a multi-element antenna system where the selecting comprises selecting an optimum number of antennas to maximize a minimum signal-to-noise ratio (SNR) margin.

Malaender does not teach or suggest Applicant's claimed method including selecting an optimum number of antennas to maximize a minimum signal-to-noise ratio (SNR) margin in a multi-element antenna system. In fact, the Examiner concedes that "Malaender fails to expressly teach where said selecting comprises selecting an optimum number of antennas to maximize a minimum signal-to-noise (SNR) margin." (*See* Office Action Dated October 17, 2006 at pg. 5.) The proposed addition of Kadous fails to alleviate the deficiencies of Malaender.

While the Examiner alleges that Kadous discloses the claimed features at col. 16, ll. 15-33 and cols. 11-16, the cited portions of Kadous fail to support the allegation. For example, the cited portions of Kadous disclose selecting the detected symbol streams with the highest margin, where the margin is determined as the difference between the equivalent SNR and the required SNR. (*See* Kadous at Col. 16, ll. 15-33.) Therefore, Kadous discloses selecting the symbol streams and not an optimum number of antennas as recited in claim 7. Merely selecting a symbol stream for recovery of the signal does not indicate that an optimum number of antennas has been determined. As described above, Kadous is merely processing the symbol streams received from N_T transmit antennas. (*See* Kadous at Col. 3, ll. 48-50-55.) Kadous does not disclose selecting an antenna for transmission, an optimum number of antennas for transmission or the constellation for the antennas. Kadous shows only processing the received symbol streams. Since merely selecting the symbol streams in Kadous reveals nothing about the ability

of the system in Kadous to select an optimum number of antennas, nothing in Kadous should reasonably be construed as <u>selecting an optimum number of antennas to maximize a minimum signal-to-noise ratio (SNR) margin in the transmission system</u> as recited in claim 7. Therefore, even if Malaender and Kadous could somehow be combined, which is not conceded, the combination would still fail to disclose or suggest each and every feature of claim 7. Accordingly, Applicant respectfully asserts that claim 7 is allowable over the combination of Malaender and Kadous for at least this reason.

<u>Claim 15 and its dependent claims</u>

Claims 13, 15, 16, 17, 19 and 21 were rejected for allegedly being unpatentable over Malaender in view of Kadous.

Claim 15 should be allowable over the proposed combination of Malaender and Kadous for at least reasons similar to claim 4. In particular, the proposed combination fails to teach or suggest, "[a]n apparatus comprising: a processor operative to select a subset of active antennas from a plurality of available antennas based on higher-order statistics of a propagation medium, wherein the processor is operative to select a constellation for transmission on the active antennas and to <u>select different constellations for two or more of the active antennas</u>" as recited in claim 15. (Emphasis added.)

Claims 13, 16, 17, 19 and 21 depend from claim 15 and are allowable over the combination of Malaender and Kadous for at least the same reasons as claim 15.

Claim 18

Claim 18 is rejected as allegedly being unpatentable over Malaender in view of Kadous.

Claim 18 should be allowable over the proposed combination of Malaender and Kadous for at least reasons similar to claim 7. In particular, the proposed combination fails to teach or suggest, "[a]n apparatus comprising: a processor operative to select a subset of active antennas from a plurality of available antennas based on higher-order statistics of a propagation medium where the processor is operative to select an optimum number of antennas to maximize a minimum signal-to-noise ratio (SNR) margin" as recited in claim 18. (Emphasis added.)

Claim 26 and its dependent claims

Claims 24, 26, 27, 28, 30 and 32 were rejected as allegedly being unpatentable over Malaender in view of Kadous.

Claim 26 should be allowable over the proposed combination of Malaender and Kadous for at least reasons similar to claim 4. In particular, the proposed combination fails to teach or suggest, "[a]n apparatus comprising: a processor including means for selecting a subset of active antennas from a plurality of available antennas based on higher-order statistics of a propagation medium and means for selecting a constellation for transmission on the active antennas including means for selecting different constellations for two or more of the active antennas" as recited in claim 26. (Emphasis added.)

Claims 24, 27, 28, 30 and 32 depend from claim 26 and are allowable over the combination of Malaender and Kadous for at least the same reasons as claim 26.

Claim 29

Claim 29 was rejected as allegedly being unpatentable over Malaender in view of Kadous.

Claim 29 should be allowable over the proposed combination of Malaender and Kadous for at least reasons similar to claim 7. In particular, the proposed combination fails to teach or suggest, "[a]n apparatus comprising: a processor including means for selecting a subset of active antennas from a plurality of available antennas based on higher-order statistics of a propagation medium, where said selecting comprises selecting an optimum number of antennas to maximize a minimum signal-to-noise ratio (SNR) margin" as recited in claim 29. (Emphasis added.)

Claim 37 and its dependent claims

Claim 35, 37, 38, 39, 41 and 43 were rejected for allegedly being unpatentable over Malaender in view of Kadous.

Claim 37 should be allowable over the proposed combination of Malaender and Kadous for at least reasons similar to claim 4. In particular, the proposed combination fails to teach or suggest, "[a] system comprising: a propagation medium; a first transceiver including a plurality of available antennas; a second transceiver including a plurality of available antennas, a processor operative to determine higher-order statistics of the propagation medium from signals received from the plurality of available antennas at the first transceiver; and an antenna selection module operative to select a subset of active antennas from the plurality of available antennas based on higher-order statistics of the propagation medium, where the processor is operative to select a constellation for transmission on the active antennas and select different constellations for two or more of the active antennas" as recited in claim 37. (Emphasis added.)

Claims 35, 38, 39, 41, and 43 depend from claim 37 and are allowable over the proposed combination of Malaender and Kadous for at least the same reasons as claim 37.

Claim 40 and its dependent claims

Claims 40 and 57 were rejected for allegedly being unpatentable over Malaender in view of Kadous.

Claim 40 should be allowable for at least reasons similar to claim 7. In particular, the proposed combination fails to teach or suggest, "[a] system comprising: a propagation medium; a first transceiver including a plurality of available antennas; a second transceiver including a plurality of available antennas, a processor operative to determine higher-order statistics of the propagation medium from signals received from the plurality of available antennas at the first transceiver; and an antenna selection module operative to select a subset of active antennas from the plurality of available antennas based on higher-order statistics of the propagation medium, where the processor is operative to select an optimum number of antennas to maximize a minimum signal-to-noise ratio (SNR) margin" as recited in claim 40. (Emphasis added.)

Claim 57 depends from claim 40 and is allowable over the proposed combination of Malaender and Kadous for at least the same reasons as claim 40.

Claim 48 and its dependent claims

Claims 46, 48, 49, 50, 52 and 54 were rejected for allegedly being unpatentable over Malaender in view of Kadous.

Claim 48 should be allowable over the proposed combination of Malaender and Kadous for at least reasons similar to claim 4. In particular, the proposed combination fails to teach or suggest, "[a] computer program comprising the steps of: selecting a subset of active antennas from a plurality of available antennas in an multi-element antenna system based on higher-order statistics of a propagation medium; and selecting a constellation for transmission on the active antennas including selecting different constellations for two or more of the active antennas" as recited in claim 48. (Emphasis added.)

Claims 46, 49, 50, 52 and 54 depend from claim 48 and are allowable over the proposed combination of Malaender and Kadous for at least the same reasons as claim 48.

Claim 51

Claim 51 was rejected as allegedly being unpatentable over Malaender in view of Kadous.

Claim 51 should be allowable over the proposed combination of Malaender and Kadous for at least reasons similar to claim 7. In particular, the proposed combination fails to teach or suggest, "[a] computer program comprising the steps of: selecting a subset of active antennas from a plurality of available antennas in an multi-element antenna system based on higher-order statistics of a propagation medium <u>where said selecting comprises selecting an optimum number of antennas to maximize a minimum signal-to-noise ratio (SNR) margin</u>" as recited in claim 51. (Emphasis added.)

Please apply the $500 brief fee and any other charges or credits to Deposit Account No. 06-1050.

Respectfully submitted,

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Appendix of Claims

1. (Cancelled)

2. (Previously Presented) The method of claim 4, wherein the higher-order statistics comprise second-order statistics of the propagation medium.

3. (Cancelled)

4. (Previously Presented) A method comprising:

selecting a subset of active antennas from a plurality of available antennas in a multi-element antenna system based on higher-order statistics of a propagation medium; and

selecting a constellation for transmission on the active antennas, where said selecting the constellation for transmission on the active antennas comprises selecting different constellations for two or more of the active antennas.

5. (Previously Presented) The method of claim 4, where the multi-element antenna system comprises a multiple-in multiple-out (MIMO) system.

6. (Previously Presented) The method of claim 4, where said selecting comprises selecting the subset of active antennas based on correlation matrices among the active antennas.

7. (Previously Presented) A method comprising:

selecting a subset of active antennas from a plurality of available antennas in a multi-element antenna system based on higher-order statistics of a propagation medium, where said selecting comprises selecting an optimum number of antennas to maximize a minimum signal-to-noise ratio (SNR) margin.

8. (Previously Presented) The method of claim 4, where said selecting comprises selecting the subset of active antennas based on a fixed data rate.

9. (Previously Presented) A method comprising:

selecting a subset of active antennas from a plurality of available antennas in a multi-element antenna system based on higher-order statistics of a propagation medium where said selecting comprises determining a subset including M_T active transmit antennas substantially in accordance with the equation

$(M_T, p) = \arg\max_{(\widetilde{M}_T, \widetilde{p})} \frac{\lambda \min(\mathrm{R}_T(\widetilde{M}_T, \widetilde{p}))}{\widetilde{M}_T(2^{b_T/\widetilde{M}_T} - 1)} \cdot \overline{\lambda}_{\min}(\mathrm{H}_w^*(K_R, \widetilde{M}_T)\mathrm{H}_w(K_R, \widetilde{M}_T))$, where p denotes indices of the M_T active transmit antennas, $\widetilde{M}_T$ represents a dummy variable for optimizing the M_T active transmit antennas, $\widetilde{p}$ represents a dummy variable for optimizing the p indices, λ_{min} represents a minimum eigenvalue, $\mathrm{R}_T(\widetilde{M}_T, \widetilde{p})$ represents a correlation matrix among the M_T active transmit antennas, $\overline{\lambda}_{\min}(\mathrm{H}_w^*(K_R, \widetilde{M}_T)\mathrm{H}_w(K_R, \widetilde{M}_T))$ represents a mean eigenvalue of a

square matrix $(\mathrm{H}_w^*(K_R,\widetilde{M}_T)\mathrm{H}_w(K_R,\widetilde{M}_T))$, $\mathrm{H}_w(K_R,\widetilde{M}_T)$ represents an $K_R \mathrm{X} \widetilde{M}_T$ matrix having distributed elements, $\mathrm{H}_w^*(K_R,\widetilde{M}_T)$ represents a complex conjugate of matrix $\mathrm{H}_w(K_R,\widetilde{M}_T)$, K_R represents a number of receive antennas, $(2^{b_T/\widetilde{M}_T}-1)$ represents a constellation for the M_T active transmit antennas, and b_T represents a fixed data rate.

10. (Previously Presented) The method of claim 4, further comprising allocating substantially equal power to each of said active antennas.

11. (Previously Presented) A method comprising:

selecting a subset of active antennas from a plurality of available antennas in a multi-element antenna system based on higher-order statistics of a propagation medium where said selecting comprises determining a subset including M_T active transmit antennas substantially in accordance with the equation

$(M_T,p)=\arg\max_{(\widetilde{M}_T,\widetilde{p})}\left\{\frac{1}{\widetilde{M}_T}\left[\ln\det\left(\mathrm{R}_T(\widetilde{M}_T,\widetilde{p})\right)+\sum_{j=1}^{\widetilde{M}_T}\sum_{i=1}^{K_R-j}\frac{1}{i}-b_T\ln 2\right]-\ln\widetilde{M}_T\right\}$, where p represents indices of the M_T active transmit antennas, $\widetilde{M}_T$ represents a dummy variable for optimizing the M_T active transmit antennas, $\widetilde{p}$ represents a dummy variable for optimizing the p indices, $\mathrm{R}_T(\widetilde{M}_T,\widetilde{p})$ represents a correlation matrix among the M_T active transmit antennas, K_R represents a number of receive antennas, and b_T represents a fixed data rate.

12. (Cancelled)

13. (Previously Presented) The apparatus of claim 15, wherein the higher-order statistics comprise second-order statistics of the propagation medium.

14. (Cancelled)

15. (Previously Presented) An apparatus comprising:

a processor operative to select a subset of active antennas from a plurality of available antennas based on higher-order statistics of a propagation medium, wherein the processor is operative to select a constellation for transmission on the active antennas and to select different constellations for two or more of the active antennas.

16. (Previously Presented) The apparatus of claim 15, where the apparatus comprises at least a portion of a multiple-in multiple-out (MIMO) device.

17. (Previously Presented) The apparatus of claim 15 where the processor is operative to select the subset of active antennas based on correlation matrices among the active antennas.

18. (Previously Presented) An apparatus comprising:

a processor operative to select a subset of active antennas from a plurality of available antennas based on higher-order statistics of a propagation medium where the processor is operative to select an optimum number of antennas to maximize a minimum signal-to-noise ratio (SNR) margin.

19. (Previously Presented) The apparatus of claim 15, where the processor is operative to select the subset of active antennas based on a fixed data rate.

20. (Previously Presented) An apparatus comprising:

a processor operative to select a subset of active antennas from a plurality of available antennas based on higher-order statistics of a propagation medium where the processor is operative to select a subset including M_T active transmit antennas substantially in accordance with the equation $(M_T, p) = \arg\max_{(\tilde{M}_T, \tilde{p})} \frac{\lambda \min(R_T(\tilde{M}_T, \tilde{p}))}{\tilde{M}_T(2^{b_T/\tilde{M}_T} - 1)} \cdot \bar{\lambda}_{\min}(H_w^*(K_R, \tilde{M}_T) H_w(K_R, \tilde{M}_T))$, where p represents indices of the M_T active transmit antennas, $\tilde{M}_T$ represents a dummy variable for optimizing the M_T active transmit antennas, $\tilde{p}$ represents a dummy variable for optimizing the p indices, $\lambda_{\min}$ represents a minimum eigenvalue, $R_T(\tilde{M}_T, \tilde{p})$ represents a correlation matrix among the M_T active transmit antennas, $\bar{\lambda}_{\min}(H_w^*(K_R, \tilde{M}_T) H_w(K_R, \tilde{M}_T)$ represents a mean eigenvalue of a square matrix $(H_w^*(K_R, \tilde{M}_T) H_w(K_R, \tilde{M}_T))$, $H_w(K_R, \tilde{M}_T)$ represents an $K_R \mathrm{X} \tilde{M}_T$ matrix having distributed elements, $H_w^*(K_R, \tilde{M}_T)$ represents a complex conjugate of matrix $H_w(K_R, \tilde{M}_T)$, K_R represents a number of receive antennas, $(2^{b_T/\tilde{M}_T} - 1)$ represents a constellation for the M_T active transmit antennas, and b_T represents a fixed data rate.

21. (Previously Presented) The apparatus of claim 15 where the processor is operative to allocate substantially equal power to each of said active antennas.

22. (Currently Amended) An apparatus comprising:

a processor operative to select a subset of active antennas from a plurality of available antennas based on higher-order statistics of a propagation medium where the processor is operative to select a subset including M_T active transmit antennas substantially in accordance with the equation $\left(M_T, p\right) = \arg\max_{(\widetilde{M}_T,\widetilde{p})}\left\{\frac{1}{\widetilde{M}_T}\left[\ln\det\left(R_T(\widetilde{M}_T,\widetilde{p})\right) + \sum_{j=1}^{\widetilde{M}_T}\sum_{i=1}^{K_R-j}\frac{1}{i} - b_T \ln 2\right] - \ln\widetilde{M}_T\right\}$,

where p denotes indices of the M_T active transmit antennas, $\widetilde{M}_T$ represents a dummy variable for optimizing the M_T active transmit antennas, $\widetilde{p}$ represents a dummy variable for optimizing the p indices, $R_T(\widetilde{M}_T,\widetilde{p})$ represents a correlation matrix among the M_T active transmit antennas, K_R represents a number of receive antennas, and b_T represents a fixed data rate.

23. (Cancelled)

24. (Previously Presented) The apparatus of claim 26, wherein the higher-order statistics comprise second-order statistics of the propagation medium.

25. (Cancelled)

26. (Previously Presented) An apparatus comprising:

a processor including means for selecting a subset of active antennas from a plurality of available antennas based on higher-order statistics of a propagation medium and means for selecting a constellation for transmission on the active antennas including means for selecting different constellations for two or more of the active antennas.

27. (Previously Presented) The apparatus of claim 26, where the apparatus comprises at least a portion of a multiple-in multiple-out (MIMO) device.

28. (Previously Presented) The apparatus of claim 26 further comprising means for selecting the subset of active antennas based on correlation matrices among the active antennas.

29 (Previously Presented) An apparatus comprising:

a processor including means for selecting a subset of active antennas from a plurality of available antennas based on higher-order statistics of a propagation medium, where said selecting comprises selecting an optimum number of antennas to maximize a minimum signal-to-noise ratio (SNR) margin.

30. (Previously Presented) The apparatus of claim 26, further comprising means for selecting the subset of active antennas based on a fixed data rate.

31. (Previously Presented) An apparatus comprising:

a processor including means for selecting a subset of active antennas from a plurality of available antennas based on higher-order statistics of a propagation medium and means for determining a subset including M_T active transmit antennas substantially in accordance with the equation $(M_T, p) = \arg\max_{(\tilde{M}_T, \tilde{p})} \frac{\lambda \min(R_T(\tilde{M}_T, \tilde{p}))}{\tilde{M}_T(2^{b_T/\tilde{M}_T} - 1)} \cdot \overline{\lambda}_{\min}(H_w^*(K_R, \tilde{M}_T) H_w(K_R, \tilde{M}_T))$, where p represents indices of the M_T active transmit antennas, $\tilde{M}_T$ represents a dummy variable for

optimizing the M_T active transmit antennas, $\widetilde{p}$ represents a dummy variable for optimizing the p indices, λ_{min} represents a minimum eigenvalue, $R_T(\widetilde{M}_T, \widetilde{p})$ represents a correlation matrix among the M_T active transmit antennas, $\overline{\lambda}_{min}(H_w^*(K_R, \widetilde{M}_T)H_w(K_R, \widetilde{M}_T)$ represents a mean eigenvalue of a square matrix $(H_w^*(K_R, \widetilde{M}_T)H_w(K_R, \widetilde{M}_T))$, $H_w(K_R, \widetilde{M}_T)$ represents an $K_R \mathrm{X} \widetilde{M}_T$ matrix having distributed elements, $H_w^*(K_R, \widetilde{M}_T)$ represents a complex conjugate of matrix $H_w(K_R, \widetilde{M}_T)$, K_R represents a number of receive antennas, $(2^{b_T/\widetilde{M}_T} - 1)$ represents a constellation for the M_T active transmit antennas, and b_T represents a fixed data rate.

32. (Previously Presented) The apparatus of claim 26, further comprising means for allocating substantially equal power to each of said active antennas.

33. (Previously Presented) An apparatus comprising:

a processor including means for selecting a subset of active antennas from a plurality of available antennas based on higher-order statistics of a propagation medium and means for determining a subset including M_T active transmit antennas substantially in accordance with the equation $(M_T, p) = \arg\max_{(\widetilde{M}_T, \widetilde{p})}\left\{\frac{1}{\widetilde{M}_T}\left[\ln\det\left(R_T(\widetilde{M}_T, \widetilde{p})\right) + \sum_{j=1}^{\widetilde{M}_T}\sum_{i=1}^{K_R-j}\frac{1}{i} - b_T\ln 2\right] - \ln\widetilde{M}_T\right\}$, where p represents indices of the M_T active transmit antennas, $\widetilde{M}_T$ represents a dummy variable for optimizing the M_T active transmit antennas, $\widetilde{p}$ represents a dummy variable for optimizing the p indices, $R_T(\widetilde{M}_T, \widetilde{p})$ represents a correlation matrix among the M_T active transmit antennas, K_R denote a number of receive antennas, and b_T represents a fixed data rate.

34. (Cancelled)

35. (Previously Presented) The system of claim 37, wherein the higher-order statistics comprise second-order statistics of the propagation medium.

36. (Cancelled)

37. (Previously Presented) A system comprising:

a propagation medium;

a first transceiver including a plurality of available antennas;

a second transceiver including

a plurality of available antennas

a processor operative to determine higher-order statistics of the propagation medium from signals received from the plurality of available antennas at the first transceiver; and

an antenna selection module operative to select a subset of active antennas from the plurality of available antennas based on higher-order statistics of the propagation medium, where the processor is operative to select a constellation for transmission on the active antennas and select different constellations for two or more of the active antennas.

38. (Previously Presented) The system of claim 37, where the system comprises at least a portion of a multiple-in multiple-out (MIMO) device.

39. (Previously Presented) The system of claim 37 where the processor is operative to select the subset of active antennas based on correlation matrices among the active antennas.

40 (Previously Presented) A system comprising:

a propagation medium;

a first transceiver including a plurality of available antennas;

a second transceiver including

a plurality of available antennas

a processor operative to determine higher-order statistics of the propagation medium from signals received from the plurality of available antennas at the first transceiver; and

an antenna selection module operative to select a subset of active antennas from the plurality of available antennas based on higher-order statistics of the propagation medium,

where the processor is operative to select an optimum number of antennas to maximize a minimum signal-to-noise ratio (SNR) margin.

41. (Previously Presented) The system of claim 37 where the processor is operative to select the subset of active antennas based on a fixed data rate.

42. (Previously Presented) A system comprising:

a propagation medium;

a first transceiver including a plurality of available antennas;

a second transceiver including

a plurality of available antennas

a processor operative to determine higher-order statistics of the propagation medium from signals received from the plurality of available antennas at the first transceiver; and

an antenna selection module operative to select a subset of active antennas from the

plurality of available antennas based on higher-order statistics of a propagation medium, where the processor is operative to select a subset including M_T active transmit antennas substantially in accordance with the equation

$(M_T, p) = \arg\max_{(\widetilde{M}_T, \widetilde{p})} \frac{\lambda \min(R_T(\widetilde{M}_T, \widetilde{p}))}{\widetilde{M}_T(2^{b_T/\widetilde{M}_T} - 1)} \cdot \overline{\lambda}_{\min}(H_w^*(K_R, \widetilde{M}_T) H_w(K_R, \widetilde{M}_T))$, where p represents indices of the M_T active transmit antennas, $\widetilde{M}_T$ represents a dummy variable for optimizing the M_T active transmit antennas, $\widetilde{p}$ represents a dummy variable for optimizing the p indices, $\lambda_{\min}$ represents a minimum eigenvalue, $R_T(\widetilde{M}_T, \widetilde{p})$ represents a correlation matrix among the M_T active transmit antennas, $\overline{\lambda}_{\min}(H_w^*(K_R, \widetilde{M}_T) H_w(K_R, \widetilde{M}_T))$ represents a mean eigenvalue of a square matrix $(H_w^*(K_R, \widetilde{M}_T) H_w(K_R, \widetilde{M}_T))$, $H_w(K_R, \widetilde{M}_T)$ represents an $K_R \mathrm{X} \widetilde{M}_T$ matrix having distributed elements, $H_w^*(K_R, \widetilde{M}_T)$ represents a complex conjugate of matrix $H_w(K_R, \widetilde{M}_T)$, K_R represents a number of receive antennas, $(2^{b_T/\widetilde{M}_T} - 1)$ represents a constellation for the M_T active transmit antennas, and b_T represents a fixed data rate.

43. (Previously Presented) The system of claim 37 where the processor is operative to allocate substantially equal power to each of said active antennas.

44. (Previously Presented) A system comprising:

a propagation medium;

a first transceiver including a plurality of available antennas;

a second transceiver including a plurality of available antennas;

a processor operative to determine higher-order statistics of the propagation medium from signals received from the plurality of available antennas at the first transceiver; and

an antenna selection module operative to select a subset of active antennas from the plurality of available antennas based on higher-order statistics of the propagation medium, where the processor is operative to select a subset including M_T active transmit antennas substantially in accordance with the equation

$$(M_T, p) = \arg \max_{(\widetilde{M}_T, \widetilde{p})} \left\{ \frac{1}{\widetilde{M}_T} \left[\ln \det\left(R_T(\widetilde{M}_T, \widetilde{p})\right) + \sum_{j=1}^{\widetilde{M}_T} \sum_{i=1}^{K_R - j} \frac{1}{i} - b_T \ln 2 \right] - \ln \widetilde{M}_T \right\}$$, where p represents indices of the M_T active transmit antennas, $\widetilde{M}_T$ represents a dummy variable for optimizing the M_T active transmit antennas, $\widetilde{p}$ represents a dummy variable for optimizing the p indices, $R_T(\widetilde{M}_T, \widetilde{p})$ represents a correlation matrix among the M_T active transmit antennas, K_R represents a number of receive antennas, and b_T represents a fixed data rate.

45. (Cancelled)

46. (Previously Presented) The computer program of claim 48, wherein the higher-order statistics comprise second-order statistics of the propagation medium.

47. (Cancelled)

48. (Previously Presented) A computer program comprising the steps of:

selecting a subset of active antennas from a plurality of available antennas in an multi-element antenna system based on higher-order statistics of a propagation medium; and

selecting a constellation for transmission on the active antennas including selecting different constellations for two or more of the active antennas.

49. (Previously Presented) The computer program of claim 48 where the multi-element antenna system comprises a multiple-in multiple-out (MIMO) system.

50. (Previously Presented) The computer program of claim 48 where said selecting comprises selecting the subset of active antennas based on correlation matrices among the active antennas.

51. (Previously Presented) A computer program comprising the steps of:

selecting a subset of active antennas from a plurality of available antennas in an multi-element antenna system based on higher-order statistics of a propagation medium where said selecting comprises selecting an optimum number of antennas to maximize a minimum signal-to-noise ratio (SNR) margin.

52. (Previously Presented) The computer program of claim 48 where said selecting comprises selecting the subset of active antennas based on a fixed data rate.

53. (Previously Presented) A computer program comprising the steps of:

selecting a subset of active antennas from a plurality of available antennas in an multi-element antenna system based on higher-order statistics of a propagation medium, wherein said selecting comprises determining a subset including M_T active transmit antennas substantially in accordance with the equation

$$(M_T, p) = \underset{(\widetilde{M}_T, \widetilde{p})}{\arg\max} \frac{\lambda \min(\mathrm{R}_T(\widetilde{M}_T, \widetilde{p}))}{\widetilde{M}_T(2^{b_T/\widetilde{M}_T} - 1)} \cdot \overline{\lambda}_{\min}(\mathrm{H}_w^*(K_R, \widetilde{M}_T)\mathrm{H}_w(K_R, \widetilde{M}_T)),$$ where p represents

indices of the M_T active transmit antennas, $\widetilde{M}_T$ represents a dummy variable for optimizing the M_T active transmit antennas, $\widetilde{p}$ represents a dummy variable for optimizing the p indices, λ_{min} represents a minimum eigenvalue, $\mathrm{R}_T(\widetilde{M}_T, \widetilde{p})$ represents a correlation matrix among the M_T active transmit antennas, $\overline{\lambda}_{\min}(\mathrm{H}_w^*(K_R, \widetilde{M}_T)\mathrm{H}_w(K_R, \widetilde{M}_T)$ represents a mean eigenvalue of a square matrix $(\mathrm{H}_w^*(K_R, \widetilde{M}_T)\mathrm{H}_w(K_R, \widetilde{M}_T))$, $\mathrm{H}_w(K_R, \widetilde{M}_T)$ represents an $K_R \mathrm{X} \widetilde{M}_T$ matrix having distributed elements, $\mathrm{H}_w^*(K_R, \widetilde{M}_T)$ represents a complex conjugate of matrix $\mathrm{H}_w(K_R, \widetilde{M}_T)$, K_R represents a number of receive antennas, $(2^{b_T/\widetilde{M}_T} - 1)$ represents a constellation for the M_T active transmit antennas, and b_T represents a fixed data rate.

54. (Previously Presented) The computer program of claim 48 further comprising generating a signal operative to allocate substantially equal power to each of said active antennas.

55. (Previously Presented) A computer program comprising the steps of:

selecting a subset of active antennas from a plurality of available antennas in an multi-element antenna system based on higher-order statistics of a propagation medium, wherein said selecting comprises determining a subset including M_T active transmit antennas [by solving for] substantially in accordance with the equation

$$(M_T, p) = \arg\max_{(\widetilde{M}_T, \widetilde{p})} \left\{ \frac{1}{\widetilde{M}_T} \left[\ln\det\left(R_T(\widetilde{M}_T, \widetilde{p})\right) + \sum_{j=1}^{\widetilde{M}_T} \sum_{i=1}^{K_R - j} \frac{1}{i} - b_T \ln 2 \right] - \ln \widetilde{M}_T \right\},$$ where p represents indices of the M_T active transmit antennas, $\widetilde{M}_T$ represents a dummy variable for optimizing the M_T active transmit antennas, $\widetilde{p}$ represents a dummy variable for optimizing the p indices, $R_T(\widetilde{M}_T, \widetilde{p})$ represents a correlation matrix among the M_T active transmit antennas, K_R represents a number of receive antennas, and b_T represents a fixed data rate.

56. (Cancelled)

57. (Previously Presented) The system of claim 40, wherein the higher-order statistics comprise second-order statistics of the propagation medium.

58. (Previously Presented) The system of claim 42, wherein the higher-order statistics comprise second-order statistics of the propagation medium.

59. (Previously Presented) The system of claim 44, wherein the higher-order statistics comprise second-order statistics of the propagation medium.

Evidence Appendix

None.

Related Proceedings Appendix

None.